Title: Public infrastructure: Pork or jobs creator?
Subject(s): INFRASTRUCTURE (Economics) -- United States; LABOR market -- United States
Source: Public Finance Review, Jan98, Vol. 26 Issue 1, p24, 29p, 2 charts
Author(s): Dalenberg, Douglas R.; Partridge, Mark D.; et al
Abstract: Investigates the relationship between state employment growth and the provision of state public infrastructure in the United States. Use of model that incorporates infrastructure impacts from several different sources; Positive spillover impacts of surrounding state highway public capital; Advantages of examining the impact of public infrastructure directly on employment rather than on output or costs.
AN: 34651
ISSN: 1091-1421

PUBLIC INFRASTRUCTURE: PORK OR JOBS CREATOR?

Abstract

Past studies of the impact of public capital on statement economic well-being have often focused on estimates of production functions, yet such an approach overlooks some important economic relationships. This article presents estimates designed to carefully measure the impact of public capital on state employment by using a model that incorporates infrastructure impacts from several different sources. Controlling for differences in states' industrial structure, demand conditions, production costs, demographics, and noninfrastructure amenities and state fixed effects, the authors find that infrastructure is a significant variable in determining state employment. Moreover, surrounding state highway public capital apparently has positive spillover impacts. Finally, a simulation is conducted to examine whether a government policy of raising taxes to fund an increase in public infrastructure increases employment.

Although economists agree that public capital plays an important role in the U.S. economy, there is much controversy regarding the "optimal" level of public capital. In particular, much of the debate has focused on public capital's influence on output or productivity. By contrast, using data for 48 states from 1972-1991, we examine the relationship between public capital and state employment. This allows us to determine the marginal impact of public capital on employment. Furthermore, we also include taxes in the specification, which allows us to assess the trade-off between the costs and benefits of public capital in terms of employment.

Attempts to measure the impact of public capital using a production function approach go back to Mera (1973) and Ratner (1983). However, a study by Aschauer (1989) pushed public capital into the national spotlight. Aschauer found that nonmilitary public capital was a significant input into a national production function and that the implied marginal product of public capital was quite high. Aschauer's results started an avalanche of studies designed to refine the estimates of the impact of public capital on production. Many of these studies are reviewed in Eberts (1990), Munnell (1992), and Gramlich (1994).

Although these studies generated considerable interest, they also generated much controversy. For example, studies based on national data have generally found a positive infrastructure-output link, but research efforts have begun to shift to state-level panel data because they have significant cross-sectional variation. This cross-sectional variation has the advantage of 48 or 50 observations per time period, versus one observation using national data. Among other things, the additional degrees of freedom improve the statistical significance of the estimates. Consistent with national studies, the original state-level research found a positive output-public capital link (e.g., Munnell 1990; Garcia-Mila and McGuire 1992). Similarly, Moomaw, Mullen, and Williams (1995) found a positive output relationship for some forms of public capital using a random effects model. However, several recent state-level production function studies have found little association between output and public capital (e.g., Holtz-Eakin 1994; Garcia-Mila, McGuire, and Porter 1996; Kelejian and Robinson 1997). Most important, these studies have found that when controlling for state fixed effects, the positive output-public infrastructure link found in ordinary least squares (OLS) and random effects models disappears. Therefore, given the existing aggregate state-level production function findings, doubt exists regarding whether public capital played a major role in the decline in U.S. productivity growth and output growth since the early 1970s (Gramlich 1994; Crihfield and Panggabean 1995; Holtz-Eakin and Schwartz 1995).

Although potentially useful, the production function approach suffers from some disadvantages, especially at the state level. Production functions require measurements of state output, which are difficult to derive. This problem is confounded because price deflators at the state level do not currently exist (see Renshaw, Trott, and Friedenberg 1988, 30). Statistical problems also contribute to the controversy. Such problems include the potential endogeneity of inputs and outputs, stationarity issues with time-series data, spillover effects, and the treatment of fixed and random effects with pooled data. Most important, production functions omit infrastructure's locational effects on inputs.

Cost functions are an alternative approach to estimating infrastructure's impact. Although this approach has some advantages, such as better data being available for input prices versus input levels, the results are still ambiguous. Eberts (1986), Lynde and Richmond (1992), Nadiri and Mamuneas (1994), and Seitz and Licht (1995) have used a cost function and found labor and public capital to be substitutes. However, Dalenberg (1987) and Shah (1992) found labor and public capital to be complements. In estimating profit functions, Deno (1988) found that labor and public capital were complements, but Crihfield and Panggabean (1996) found more ambiguous results. Finally, using Swedish data, Berndt and Hansson (1992) found that labor and public capital were complements in some time periods and substitutes in other periods.

Being dual to the production function approach, the cost function approach suffers from some of the same problems. For example, because the cost functions focus on conditional factor demands, they also miss important indirect effects. Immergluck (1993) argues that there are three ways that public infrastructure affects the economy: (a) as a paid and/or unpaid input, (b) as an amenity that attracts inputs, and (c) as an augmenting factor that interacts with other inputs and affects their productivity. Thus, cost function estimates, like production function estimates, may miss or understate the second and third of Immergluck's impacts.

This article examines the impact of public infrastructure directly on employment rather than on output or costs. This specification has several important advantages. First, employment data are more reliable than state-level output data, and employment does not need to be deflated. Second, production and cost functions may not adequately isolate the impact of public capital. By increasing location-specific amenities, public infrastructure may increase employment, yet the production and cost function estimates do not capture this indirect effect of public capital. Third, although marginal products are of interest, politicians also want to know the impact of additional public capital spending on the number of jobs. Fourth, production and cost functions have not adequately controlled for other important variables. Our approach allows us to control for differences in states' industrial structure, demand conditions, production costs, demographics, and noninfrastructure amenities.[1] Fifth, production and cost functions contain no explicit cost-benefit trade-offs between output and taxes but rather must address such trade-offs indirectly. Our employment equation includes both public capital and taxes; thus, the trade-off is explicit. Finally, because of the large sample size--48 states for 20 years--we are better able to test for state fixed and random effects, autocorrelation, spatial autocorrelation, endogeneity, and model mis-specification. Therefore, we are able to address many of the econometric criticisms raised in this literature.

I. MODEL OF STATE EMPLOYMENT GROWTH

A myriad of factors may influence state employment growth. These include national employment trends, a state's industrial structure, spatial product market demand shifts, demographic characteristics, and location-specific factors. Public infrastructure is among the location-specific factors that may affect employment growth.

In addition to its role as an unpaid input in production (Meade 1952), state public infrastructure can increase the amenity attractiveness of a state to both firms and households (Dalenberg and Partridge 1997; Fox and Murray 1990). As a firm amenity, public infrastructure stimulates input demand. For example, less congested highways reduce transportation costs to firms, which increase profitability. As a household amenity, public capital increases the desirability of the area, stimulating net migration and increasing labor supply. Undoubtedly, reduced highway congestion also has economic value to households. Both of these amenity effects can influence firm site selection. Examination of employment growth accounts for the role of public infrastructure as a firm and household amenity in addition to its role as an unpaid input. In contrast, production function frameworks view public infrastructure only as an unpaid input, which overlooks infrastructure's influence as a household amenity on labor supply. As Holtz-Eakin (1994, 20) notes, the production function approach only considers "productivity benefits in excess of direct provision of amenities." Analogous statements can be made about the (dual) cost function approach (e.g., Morrison and Schwartz 1996) and the growth accounting framework of Hulten and Schwab (1991). For instance, if infrastructure attracts more private capital and labor, a production or cost function approach would simply treat this as input growth, not as an effect of the provision of public infrastructure.[2]

To isolate the effect of state public infrastructure, we draw on the labor and regional economic literatures to develop a reduced-form model of state employment growth. Specifically, the model includes factors that influence labor demand and labor supply that have not been used in previous infrastructure studies. Through industry location effects, labor demand is generally thought to be positively related to the average rate of profitability in a region. Factors that influence labor demand include national cyclical employment effects (us); state public infrastructure (INFRA); industry structure, including factors that shift labor demand (INDUSTRY); state production costs (COSTS), including nonwage costs and government policies; human capital and other demographic characteristics of the labor force and population (DEMOG); and firm amenities (FMAMEN). The labor supply of a region is a function of the infrastructure stock, the human capital and demographic characteristics (DEMOG) of the population, the level of wages in the region, and government policies. Population growth and labor supply are also strongly influenced by other regional household amenities (HHAMEN). HHAMEN is assumed to be a broad enough category to include obvious factors such as ***climate*** and scenery and more subtle factors such as government policies (e.g., taxes).

Based on underlying structural labor demand and labor supply equations,[3] a reduced form for relative employment growth for state r in year t can be written as a function of public capital and other labor demand and supply factors:

NETGRW[sub rt] =f(INFRA[sub rt], INDUSTRY[sub rt], COST,,
DEMOG[sub rt], FMAMEN[sub rt], HHAMEN[sub rt]) + DEMAND[sub rt].(1)

NETGRW[sub rt] is private nonfarm state employment growth minus U.S. private nonfarm employment growth, or simply relative state employment growth. NETGRW has the advantage of netting out national cyclical patterns that are common across all states (US from above). DEMAND represents exogenous demand shocks that can shift state employment growth above or below the national average in both the short and medium term. Examples of demand shocks include the state possessing a mix of industries that are faring well at the national level and economic spillovers from nearby states. Regarding public capital, if infrastructure acts as either a firm amenity that increases profitability and labor demand or as a household amenity that increases labor supply, relative employment growth will be larger. Finally, by focusing on private sector employment, the model is also consistent with current public policy priorities and follows Holtz-Eakin's (1994) use of private sector output.

Reduced-form models such as equation (1) have been widely used in the ***business*** location literature,[4] where the exact variables are described below. Specifically, in equation (1), cross-state differences in the levels of the control variables are hypothesized to cause changes in state r's employment growth relative to the nation. Moreover, equation (1) is general enough to allow for both equilibrium and disequilibrium effects that cause a state's employment growth rate to be different than the national average. For example, if greater unionization increases costs and reduces the profit rate, then employment in states with relatively high levels of unionization should grow less than the national average, ceteris paribus. Similarly, states with above-average rates of ***taxation*** will likely experience less than average net migration flows and smaller than average labor force growth rates, as well as less firm growth. Finally, in the empirical modeling, an advantage of using the change in employment as the dependent variable is that it avoids spurious relationships that may exist between the level of employment and the level of the independent variables, including the level of infrastructure. This avoids problems that can afflict some production function studies in which the level of output is regressed on the level of inputs.

II. EMPIRICAL SPECIFICATION AND DATA

Given NETGRW for state r and the factors shown in equation (1), an estimable form is obtained by assuming a linear model:

NETGRW[subrt] = alpha +Beta INFRA[sub rt] + Omega1NDUSTR[sub rt]t(2)
+ phiCOST[sub rt] + deltaDEMOG[sub rt[+ deltaDEMAND[sub rt] + detal[sub r] + e[sub r,t],

where alpha is the constant term, delta[sub r] denotes state fixed effects, and e[ub rt] is the error term. beta, theta, phi, pi, and delta represent coefficient vectors. The influence of the time-invariant components of firm and household amenity attractiveness are captured by the state fixed effects. The state fixed effects also allow for the possibility of persistent differences in state employment growth rates during our sample period. Cross-state differences in the levels of state public infrastructure and in the control variables are hypothesized to cause changes in state r's employment growth relative to the nation (NETGRW). For example, if public capital is an amenity, then employment in states with relatively greater levels of public capital should grow faster than the national average. Finally, in the empirical analysis, we will examine whether the error term e[sub rt] exhibits first-order autocorrelation:

e[sub rt] = pe[sub rt] -1 + v[sub rt] (3)

where v[sub rt] is identically and independently distributed and p is the degree of first-order autocorrelation that is assumed constant across states.

Real state per capita public infrastructure (in thousands of 1987 U.S. dollars) is separated into two components: the stock of public highways (HIGHPUBK) and the public infrastructure net of highways (NETPUBK). NETPUBK includes items such as sewer and water facilities, hospital buildings, and education facilities.[5]

Exogenous spatial shifts in producer demand, shown in the DEMAND vector, can cause differential employment growth. An important source of demand shifts is accounted for by INDMIX, where INDMIX controls for whether a state is growing faster simply because it has a concentration of fast-growing industries nationally. INDMIX is calculated using the method of the shift-share model: INDMIX equals a two-digit state employment-weighted average of national industry growth rates less the U.S. average growth rate. To allow for dynamic effects, the lag of INDMIX is also included (INDMIX(underbar)LAG).[6] Other possible product demand shifts that are controlled for include the change in farm employment as a share of total employment relative to the nation (CHFARM), the change in military expenditures in the state as a share of gross state product relative to the nation (MILITARY), differential employment growth from the United States of the remaining states in a state's census region (REGIONGR) and its lag (REGIONGRL), and nonlabor force migration such as new retirees each year (RETIREE). RETIREE is calculated as the difference between expected population ages 65 and over and actual population using the cohort survival method, expressed as a share of the population (Treyz, Rickman, and Shao 1992).

Industry structure in the INDUSTRY vector is measured by state one-digit employment shares (FARM, DURABLES, NONDURABLE, MINING, CONSTRUCTION, TRANPU, FIRE, TRADE, SERVICES).[7] Possible dynamic externalities associated with certain industries, differences in industry productivity growth, and differences in capital intensity are reasons to include the one-digit industry shares as control variables.

A major component of COST is how the state's relative wage structure compares to other states. Two measures of the state's relative wage structure are derived from annual nonfarm private wages to capture disequilibrium adjustments to differing state cost structures. First, a measure of whether the state's mix of industries is relatively high paying is calculated (WAGEMIX). Formally, WAGEMIX is the state employment-weighted average of corresponding national industry wage rates expressed relative to the average U.S. private wage rate (U.S. Bureau of Labor Statistics, ES-202 Employment Data Series, various years). A greater WAGEMIX ratio is hypothesized to positively shift labor demand through the spillover or multiplier effects of having a larger proportion of high-paying industries. Second, WAGECOMP is calculated as the ratio of the actual state wage rate divided by state employment-weighted U.S. industry wage rates (U.S. Bureau of Labor Statistics, ES-202 Employment Data Series, various years)[8] Holding the state's average wage fixed, the WAGECOMP ratio measures whether the state's wages are relatively high after taking its industry mix into account. A higher WAGECOMP indicates that the typical industry in the state is paying higher wages than the industry's national average, which suggests that the typical industry in the state may be at a competitive disadvantage. Thus, a greater WAGECOMP ratio should reduce labor demand.

The state and local tax burden (TAX%) and relative energy prices (FUEL) are included as cost controls. TAX% is measured as the state and local tax (U.S. Department of Commerce, Government Finances, various years) share of personal income (U.S. Bureau of Economic Analysis, Local Area Personal Income, various years). Taxes are an important control because they reflect (at least partially) the opportunity cost of state public infrastructure spending. Relative energy prices are calculated for commercial and industrial users (see Treyz, Rickman, and Shao 1992 for details).

Additional variables included that may affect a state's ***business climate*** and its production costs are the degree of unionization (UNION%), the availability and generosity of unemployment insurance (UI(underbar)COVER, UI(underbar)BENEFIT), and welfare assistance as a percentage of personal income (WELFARE%). UNION% is calculated as the percentage of the civilian labor force that are union members based on data from the Statistical Abstract of the United States (U.S. Department of Commerce, various years) and Hirsch and Macpherson (1993). State UI(underbar)COVER and UI(underbar)BENEFIT are measured as the percentage of civilian employment that is covered by unemployment insurance and the real average weekly unemployment insurance benefit (deflated using the consumer price index), respectively (U.S. Department of Commerce and the U.S. Employment and Training Administration, various years). WELFARE% is based on data from various issues of Government Finances (U.S. Department of Commerce, various years).

Demographic characteristics are also included as control variables. The percentage of the labor force that is male (MALE(underbar)LF%) is included to control for the effects of differential changes in female participation rates. To control for possible discrimination, labor force quality, and preferences for work, the percentage of the population that is Black (BLACKPOP%), the percentage of the population that is married (MARRIED%), the percentage that is married or unmarried women having children 6 years old or younger (CHILD6MAR, CHILD6NONMAR), the percentage that is 14 years or younger (AGE14%), and the percentage that is 65 years or older (AGE65%) are included. The demographic variables are calculated using the Census of Population (U.S. Bureau of the Census

1970, 1980, 1990) and interpolated for noncensus years. New international migrants (INTMIGRANTS) as a share of the population are included to control for exogenous labor supply shifts (U.S. Department of Commerce, Current Population Survey, various years).

The percentage of the population above age 24 who are high school graduates (HS(underbar)GRAD) and who are college graduates (COLL(underbar)GRAD) are included to control for the human capital of the labor force. These are calculated using the Census of Population (U.S. Bureau of the Census) for 1970, 1980, and 1990 and interpolated for noncensus years. To control for the possibility that urbanization is the underlying cause of both economic growth and increased public infrastructure investment (Carlino and Voith 1992), population density (POPDEN) and the natural log of the population of the largest standard metropolitan statistical area in the state at the beginning of the sample (LG(underbar)MSA) are included (U.S. Department of Commerce, Statistical Abstract of the United States, various years).

III. EMPIRICAL RESULTS

Data for the 48 contiguous states are drawn from the 1972-1991 period for a total of 960 observations. The means and standard deviations of the variables are reported in column 1 of Table 1; column 2 reports the OLS results, and columns 3 to 5 contain alternative specifications. For brevity, only the infrastructure results are emphasized below, but the other results are generally as expected.

Before proceeding to Table l's results, we present a "stripped-down" relative employment growth model that most closely replicates the specifications used in the production function framework. A major empirical distinction of our employment growth model from production function approaches is the additional industry structure, cost, and demographic factors that shift employment. Alternatively, the production function models simply assume that output is a function of inputs (see note 2). Thus, the closest analogy in our case is to regress employment growth on public capital. As a first pass, this very parsimonious regression would allow us to examine whether using employment, in itself, results in dramatically different findings than using output (e.g., through household amenity effects).

Therefore, two simple regressions are shown below (t statistics are in parentheses). The first regression does not control for the (48) state fixed effects, but the second regression controls for state fixed effects.

NETGRW[sub rt] = -.001 + 6.3E-4*HIGHPUBK + 1.4E-4*NETPUBK, R:[sup 2] =.001

(1.05) (0.21) (4)

NETGRW[sub rt] = .014*HIGHPUBK - .010*NETPUBK + beta*STATE DUMMIES, R[sup 2]= .24

(4.39) (5.54) (5)

Using equation (5), the results suggest that highway public capital is positively related to employment growth, even when state fixed effects are included, but this is not the case for net public capital. Thus, at least for highway public capital, there is some reason to believe that using employment rather than output will result in more favorable infrastructure results. However, these results are only for comparison to production function estimates because severe bias could exist because the other variables in our model are omitted. Thus, these results will not be discussed further.

Now turning to the more fully specified model, in column 2 of Table 1, highway public capital has a positive and significant influence on relative state employment growth, but the net infrastructure coefficient is statistically insignificant. The stronger highway effects and weaker net infrastructure effects are consistent with Garcia-Mila and McGuire's (1992) OLS findings and Pinnoi's (1994) random effects results for state output. It is possible that net infrastructure does not have as strong of an influence on employment growth because it partially consists of administrative buildings and other types of infrastructure that are less likely to improve productivity. Therefore, specific categories of net public infrastructure -- for example, harbors or airports -- likely have a greater employment growth influence than the average effect implied by the net infrastructure coefficient.

During the sample period, it is likely that employment growth persistently varies across states due to factors such as unmeasured time-invariant firm or household amenities. Thus, there may be omitted state fixed effects that could bias the OLS coefficients. This possibility is examined in column 3, where state fixed effects are added to the empirical model.[9] However, as Holtz-Eakin (1994) notes, by controlling for state fixed effects, the influence of cross-sectional differences in the independent variables is lost in the estimation procedure, and only the influence of within-state variation is captured (which tends to bias the coefficients toward zero if there is measurement error).

The highway and net public infrastructure results follow a similar pattern when state fixed effects are included in the model. These results somewhat differ from those of production function studies that control for state fixed effects (e.g., Holtz-Eakin 1994; Garcia-Mila, McGuire, and Porter 1996; Kelejian and Robinson 1997) in that state-level production function studies have generally found little effect for all types of infrastructure.

One empirical problem with the fixed effects model in column 3 is that the autocorrelation of the error terms was 0.39. Thus, the model shown in column 4 corrects for autocorrelation by employing generalized differencing. Because the first observation for each state is lost, the sample size falls to 912 in this model. The autocorrelation of the error terms is only 0.07 after the correction. In this formulation, both highway and net public capital are statistically significant at the 7% level in a two-tailed test. Nonetheless, highway public capital still has a larger influence than other forms of infrastructure.[10]

An obvious question is that, after fixed effects are accounted for, why does public capital appear to increase employment when previous production function research found that public infrastructure has little influence on output? Besides their omission of amenity effects, one possible reason is that production function studies also do not control for industry structure, cost, and demographic characteristics of the state.[11] Moreover, note that these results cannot be attributed to increases in employment growth during the construction of the public capital because that would be reflected in an increase in the construction share of employment, which is controlled for in this model. Therefore, given the additional variables, infrastructure's estimated influence on employment growth may be sensitive to variable selection.[12] We examined this possibility by omitting all variables that are not statistically significant at the 10% level in a two-tailed test. This alternative model is shown in column 5. In this case, most of the remaining coefficients were basically unchanged, and their statistical significance improved. Regarding the two infrastructure coefficients, both their magnitudes and statistical significance increased.

Another possible explanation for the difference in findings is that this study considers data through 1991, which is 5 to 10 years later than the period considered in the output-based studies. To examine this possibility, we separately reestimated our autocorrelation-corrected specification for the 1972-1981 and 1982-1991 time periods. Compared to the results in column 4, the net public capital coefficients were about threefold larger in both alternative specifications, suggesting that time period differences are not the cause of net infrastructure's influence. Highway public capital's coefficient was essentially zero in the 1972-1981 specification and about 0.008 in the 1982-1991 specification, which is about one third larger than the coefficient in column 4. Moreover, the meager highway influence from 1972-1981 is consistent with Dalenberg and Partridge (1995), who found that highway spending had little influence on metropolitan-area employment using 1966-1981 data. Thus, one implication is that the influence of highways on employment growth increased during our sample period.[13]

In general, the finding that greater public capital increases employment growth is robust to basic changes in the model. Nevertheless, as indicated above, a significant difference between our employment-based model and previous infrastructure research is that our model has significantly more controls for state differences in (a) industry structure and cyclical demand, (b) ***business*** and household costs, and (c) demographics, labor force quality, and changes in labor supply. Regarding the first category, some infrastructure studies partially controlled for ***business*** cycle effects by including the state unemployment rate (e.g., Munnell 1990), but industry employment structure is rarely accounted for. To some extent, cost considerations in the second category are appraised in cost function studies of infrastructure but not directly in production function studies. Finally, by carefully controlling for the third group of variables, the quality of the labor force and the amenity effect of public capital are taken into account, which is a weakness in production and cost function formulations that treat labor as homogeneous. However, a disadvantage of our reduced form model is that we cannot directly determine the precise channels that exist between public infrastructure and state employment growth.

Table 2 presents models that show the influence of omitting each group of variables one at a time to illustrate the sensitivity of the infrastructure results to not carefully accounting for these factors. In columns 1 to 3, the empirical results are presented where, respectively, the demand and structural variables, cost variables, and demographic variables are omitted from the model. Overall, except for a reduction in the significance of the highway coefficient in the model in which the demand variables are omitted, the highway public capital results are robust to these changes. Net public capital is insignificant in all three alternative models, especially in the case where the demand variables are omitted. These alternative models suggest that carefully controlling for all three categories is important in explaining why public infrastructure influences employment growth. In particular, carefully controlling for the demand and structural characteristics of a state's economy plays a prominent role for our positive findings for both highway and net public capital, and also controlling for cost and demographic attributes mattered for the net public capital results.

Our findings support Munnell's (1990) conclusion that greater infrastructure levels positively influence employment growth. However, these results are an extension of Munnell's because our model also controls for fixed effects and shows the importance of carefully accounting for demand factors, cost effects, and demographic attributes of the state.

A priori, we did not expect potential endogeneity of the infrastructure coefficients to be a concern. Specifically, that would imply that employment growth in the current period is significantly affecting the stock of public capital, which was mostly determined by investment decisions made in the previous 75 or so years. However, we do not want to dismiss the possibility that potential endogeneity of infrastructure is influencing the results.[14] For instance, expanding economies can afford to construct more infrastructure, which could positively bias the infrastructure coefficients. Similarly, high rates of employment growth could increase wages in the state's industries faster than their respective industry wages nationally, which would positively bias the WAGECOMP coefficient.[15] To test for this possibility, we conducted separate Hausman tests on the two public capital variables and the WAGECOMP variable in the autocorrelation-corrected specification shown in column 4 of Table 1.[16] The t statistic for the null hypothesis that potential endogeneity of the variables is not biasing the coefficients is shown at the bottom of column 4. Only in the case of WAGECOMP could the null hypothesis be rejected. Thus, following Greene (1993) for the case when autocorrelation is present, column 4 of Table 2 presents the results of a two-stage least square (2SLS) specification in which WAGECOMP is treated as endogenous. As expected, the WAGECOMP coefficient is more negative using 2SLS, but the infrastructure coefficients are quite similar.

One important public policy question that remains unanswered is whether it would be in the interests of policy makers to consider increasing taxes to fund more public infrastructure if their goal was to stimulate employment growth. A stylistic example using our best-guess estimates of the impacts of infrastructure and ***taxation*** in column 4 of Table 1 is used to address this issue. Assume that a given state implements a policy that respectively increases per capita net and highway infrastructure by one standard deviation, that is, $1,090 and $1,200 (in 1987 U.S. dollars). Next, assume that the addition of public infrastructure is funded by borrowing the money at a 10% interest rate that is paid off over 10 years through an increase in taxes. Thus, to fund a one-standard deviation increase in net public capital, taxes would, on average, increase by 1.23% of personal income for 10 years. Similarly, the average 10-year increase in taxes would be 1.36% of personal income to fund the increase in highway infrastructure. Using data in Munnell (1990, 12, 27) regarding the various infrastructure shams and their average service lives, net public capital and highway public capital am respectively assumed to annually depreciate 2.16% and 1.67% in a straight-line fashion.

Taxes required to finance the increase in net public capital would reduce relative employment growth 0.31% a year for 10 years. This effect is offset by the increase in net public infrastructure, which increases first-year relative employment growth 0.48%, declining to 0.38% in the 10th year due to depreciation. After 10 years, the net infrastructure influence on employment growth continues but declines at the 2.16% straight-line depreciation rate. However, after 10 years, this positive effect is no longer offset by the negative tax effect.

Taxes required to finance the increase in highway public capital would reduce annual relative employment growth 0.34% for 10 years. The corresponding change in employment growth from increased highway public infrastructure is 0.72% the first year, declining to 0.60% by the 10th year. Again, after 10 years, the highway public capital influence continues, but it declines at the 1.67% depreciation rate. Regardless, both examples show that even if state and local taxes are raised to fund increases in public capital, net state employment growth rises, even during the period when taxes are increased. [17]

Although greater public infrastructure increases a given state's employment growth rate, a related policy issue is whether the beneficial impacts of increased public infrastructure spill over into neighboring states. If so, there is justification for federal grants to states and localities in the construction of infrastructure. The potential network effects in the highway system suggest that if there are spillover effects from public capital, highway public capital is a likely candidate. Column 5 of Table 2 adds the population-weighted average of per capita highway public capital in the bordering states (BORD(underbar)HWPUBK) as an additional variable. BORD(underbar)HWPUBK represents a proxy for the extent of the neighboring states' highway system. The results indicate that the BORD(underbar)HWPUBK coefficient's magnitude and statistical significance are both large, but the net public capital results are basically unchanged. However, the own-state highway public capital's t statistic is only 1.02. At first glance, it may seem surprising that surrounding state highway public capital has a stronger influence than own-state highway public capital. However, the simple correlation between neighboring state and own-state highway public capital is 0.63, which suggests that some of the own-state highway effect is captured by the neighboring state coefficient? Regardless, these results are further evidence in support of the productivity-inducing effects of highway public capital.[19]

IV. SUMMARY AND CONCLUSION

This article examined the relationship between state employment growth and the provision of state public infrastructure. Most recent state-level research has found little connection between public capital and output after controlling for state fixed effects. However, using a different methodology, this study found a positive public capital-employment association with state fixed effects, which suggests that the public capital debate has not been settled. The level of public highway capital was found to be significantly related to state employment growth in all specifications. Public capital net of highways was also significant in a fixed effects autocorrelation-corrected specification. Moreover, simulations of infrastructure spending financed by state and local taxes yielded net increases in employment growth. Finally, public highway capital of bordering states significantly increased employment growth in the state, suggesting the existence of network effects.

The finding of positive significant employment effects of infrastructure spending with a fixed effects model contrasts with the insignificant or negative effects found by studies that estimate state production functions with state fixed effects. However, production and cost function studies implicitly ignore the amenity role of public infrastructure in attracting capital and labor. Moreover, our results reveal that accounting for industry structure, product demand shifts, cost considerations, and the quality of the labor force is important for finding some of the employment-infrastructure link, especially for the infrastructure net of public highway capital. These considerations generally are omitted in the estimation of state production and cost functions. Overall, this article suggests that more research should be conducted into the infrastructure-employment growth link, particularly the structural relationship between employment growth and infrastructure.

NOTES

1. For example, Moomaw, Mullen, and Williams (1995) note that aggregate production function studies do not account for the industrial composition of the state, which will be shown to be important in this study. In particular, Holtz-Eakin and Lovely (1996) illustrate the unique role public capital plays in the manufacturing sector. Moreover, production function studies typically do not account for cyclical conditions, major cost factors, and labor force quality (e.g., average education). Cyclical factors that aggregate production functions are not designed to account for include capital underuse and labor hoarding. However, some state-level studies partially control for aggregate demand by using state unemployment rates (e.g., Munnell 1990). Similarly, a few production function studies account for some cost factors, including Tatom (1991), who controls for energy prices.

2. This can be seen with the following empirical formulation of the natural log of the Cobb-Douglas production function for a typical state:

In(Q) = a + b[1]Ln(L) + b[2]In(K) + b[3]In(INFRA),

where Q, L, K, INFRA are, respectively, gross state product, labor force, private capital stock, and public infrastructure stock in the state. Assuming that labor and capital are attracted to states with greater levels of public capital--that is, L(INFRA), K(INFRA), L' > 0, K' > O -- taking the partial derivative of(l) with respect to INFRA and multiplying through by INFRA results in

epsilonQ,INFRA -- bIL,INFRA + b[sub 2]epsilonK,INFRA + b[sub 3],

where epsilon[sub i]INFRA is the elasticity of i with respect to public capital. Typical production function approaches used in the previous literature estimate epsilonQ.INFRA by b[sub 3], omitting the elasticity of labor and capital with respect to infrastructure. Given that b[sub 1] and b[sub 2] are, respectively, labor and capital's share of national income on average (i.e., the coefficients are large), this omission could lead to a large underestimate of the impact of public capital on economic activity. Likewise, other production functions (e.g., translog) also omit the possible influence of amenities on the location of labor and private capital. Specifically, deltaL/deltaNFRA and deltaK/deltaINFRA are assumed to be equal to zero.

3. See Eberts and Stone (1992) for an example of a simple structural model of labor supply and labor demand that incorporates public capital.

4. Regarding public capital, Dalenberg and Partridge (1995) model the impact of infrastructure on metropolitan employment using a comparable reduced-form model. Similarly, in Wasylenko and McGuire's (1985) ***business*** location model, cross-state differences in the level of taxes and other variables are assumed to influence employment growth rates in a similar fashion (for a review of alternative approaches, see Newman and Sullivan 1988). Also, similar growth-levels models have been employed in state migration (e.g., Treyz, Rickman, and Shao 1993) and unemployment studies (e.g., Partridge and Rickman 1995).

5. For 1972-1986, the state public infrastructure comes from Munnell (1990). Munnell uses a perpetual inventory technique to construct this data. For 1987-1991, we extrapolate Munnell's data using growth rates from a separate set of state infrastructure data. These data are described in Bell and McGuire (1993) and are constructed from census data using the method described in Holtz-Eakin (1993).

6. All employment-related variables are from the U.S. Bureau of Labor Statistics' ES-202 Employment Data Series (various years). Also note that by allowing the coefficient of INDMIX to differ from 1, the spillover effects to other industries of having a concentration of fast-growing industries nationally is controlled for.

7. To avoid perfect collinearity during estimation, the share of employment in government is omitted.

8. Formally, the WAGEMIX ratio for state r, year t is calculated as:

WAGEMIX[sub rt] = (sigmEMPSH[sup i]psub rt] * W [sup i]psub t])/Wust,

where EMPSH[sup l][sub rt] is industry i's share of state r's nonfarm private sector employment, WUS[sub t] is the average annual U.S. earnings in industry i, and Wust is the average U.S. nonfarm private sector annual earnings. The summation is over all nonfarm private sector industries. Formally, the WAGECOMP ratio for state r, year t is calculated as the following:

WAGECOMP[sub rt] = W[sub rt](EpsilonEMPSH [sup i]psub rt] * W'US[sub t],), where W[sub rt] is the average nonfarm annual earnings in state r. In the empirical analysis, the possible endogeneity of the wage structure measures is examined.

9. The F statistic for including the 48 state dummies was 9.00, which is significant at all conventional levels. Note that the log of the 1972 population for the state's largest metropolitan area is omitted from the fixed effects model because it is constant across time for every state.

10. Another empirical concern is that a random effects specification may be more appropriate. This possibility was analyzed with a Hausman test of the null hypothesis that the coefficients in the random effects model are unbiased (Greene 1993). The Hausman test statistic of the specification shown in column 4 equalled 93.2, where the test statistic is distributed X[sup 2](37). Thus, the null could be rejected at the 0.1% level, indicating that a fixed effects model is more suitable.

11. Focusing on just one industry (e.g., manufacturing) mitigates some industry composition effects, but industry structure may still matter through spillover effects.

12. We also experimented with a similar model that used the percentage change in real per capita personal income as the dependent variable, but our basic conclusions remain unchanged.

13. Because the average relative employment growth across the 48 states equals zero in every year by definition, average relative state employment growth does not vary by year. Nevertheless, as a test of whether common movement in the independent variables was masking the true effect of infrastructure, we added year dummies to the specification shown in column 4 (not shown). However, the infrastructure results were quite similar in this specification. This also indicates that our results would be unaffected by using year dummies instead of differencing state employment growth from U.S. employment growth.

14. We also considered the possibility that our error terms were spatially autocorrelated (e.g., employment shocks in Missouri spill over into Kansas). We tested for this possibility by assuming that spatial autocorrelation originates in bordering states and follows an error-components specification (Kelejian and Robinson 1993, 1997). We assumed that the degree of spillover into a state from a neighboring state is directly proportional to the relative size of the neighboring state's nonagricultural employment compared to the other neighboring states. Nonetheless, the null hypothesis of no spatial autocorrelation could not be rejected at any reasonable level of significance, using a test developed by Kelejian and Robinson.

15. A state's relative employment growth should not in turn have any meaningful influence on either its INDM1X employment components or its WAGEMIX compensation component because these variables are essentially determined in the national labor market (e.g., Blanchard and Katz 1992).

16. The instruments for the Hausman test and the two-stage least square (2SLS) estimates include all of the exogenous independent variables in the model, in addition to real per capita state personal income and the lags of WAGEMIX and WAGECOMP.

17. Note that the positive employment influence does not include the public works employment effect during the construction of the infrastructure. This added influence would be captured by an increased share of employment in construction. One caveat regarding the positive employment estimates is that they overstate the gains to infrastructure if there are diminishing returns to infrastructure (e.g., Dalenberg and Partridge 1995), and thus the estimates are most accurate for marginal changes (also see Hulten and Schwab 1993).

18. The own-state and bordering state highway public capital coefficients were both approximately equal to 0.010 and were statistically significant in the panel estimates that did not correct for autocorrelation (not shown).

19. If neighboring state public capital has positive spillover impacts, it is likely that these effects are due to highway public capital, not through net public capital (e.g., a city hail in Houston has few spillover effects in Louisiana, but highways in Texas do affect Louisiana). In other results (not shown), we also included bordering-state net public capital along with bordering-state highway public capital. As expected, bordering-state net public capital was insignificant, and the other three infrastructure coefficients were similar to those in column 5.

TABLE 1: Relative State Employment Regression Resulta[a,b]

```
Legend for Chart:

A - (1) Mean
B - (2) Ordinary Least Squares
C - (3) Fixed Effects
D - (4) AR1 Fixed Effects
E - (5) AR1 Fixed Effects

                        A             B             C
                                      D             E
```

EMPLOY	.001	--	--
		--	--
	(.022)	--	--
		--	--
INFRASTRUCTURE			
HIGHPUBK	3.12	.004	.012
		.006	.007
	(1.20)	(3.70)	(3.54)
		(2.03)	(2.85)
NETPUBK	3.50	6.4E-04	7.3E-04
		.004	.005
	(1.09)	(.80)	(.37)
		(1.84)	(2.49)
DEMAND OR STRUCTURAL			
INDMIX	-.002	1.83	1.61
		1.78	1.79
	(.005)	(13.08)	(15.35)
		(17.74)	(18.17)
INDMIX(underbar)LAG	-.001	.45	.30
		.38	.39
	(.006)	(3.64)	(3.03)
		(3.89)	(4.04)
FARM	.016	.022	.124
		.025	--
	(.012)	(.24)	(.68)
		(.13)	--
DURABLES	.110	.212	.125
		.059	--
	(.050)	(5.59)	(1.53)
		(.68)	--
NON DURABLE	.083	.156	.004
		.048	--
	(.044)	(3.84)	(.05)
		(.60)	--
MINING	.014	.033	.160
		-.054	--
	(.023)	(.42)	(1.11)

		(.35)	--
CONSTRUCTION	.049	.610 .885	.908 .912
	(.013)	(6.96) (7.86)	(8.90) (9.21)
TRANPU	.053	-.407 -.550	-.771 -.506
	(.010)	(3.32) (2.10)	(3.35) (2.22)
FIRE	.051	-.300 -.803	-.972 -.707
	(.012)	(2.72) (3.99)	(5.48) (4.10)
TRADE	.224	.159 .186	.072 --
	(.020)	(2.06) (1.35)	(.52) --
SERVICES	.222	.160 .386	.382 .416
	(.046)	(3.17) (3.95)	(3.75) (6.89)
CHFARM	-2.5E-04	.349 .170	.173 --
	(.002)	(1.74) (.98)	(.87) --
MILITARY	6.0E-04	.012 -.105	-.181 --
	(.005)	(.11) (.88)	(1.62) --
RETIREE	1.1E-04	-4.90 16.32	39.15 15.10
	(7.8E-04)	(2.48) (2.92)	(4.79) (3.43)
REGIONGR	.001	.288 .236	.244 .232
	(.013)	(3.56) (3.93)	(3.81) (4.19)
REGIONGRL	.002	.096	.095

		.083	--
	(.013)	(1.32)	(1.45)
		(1.31)	--
COST			
UNION%	18.34	-4.1E-04	2.7E-04
		3.4E-04	--
	(7.77)	(2.44)	(1.01)
		(1.13)	--
WAGEMIX	.991	-.006	.274
		.323	.374
	(.039)	(.14)	(3.28)
		(4.03)	(7.42)
COST			
WAGECOMP	.943	-.040	-.148
		-.171	-.184
	(.094)	(1.87)	(4.84)
		(5.21)	(7.60)
FUEL	.965	-.017	-.037
		-.034	-.029
	(.167)	(2.74)	(4.36)
		(3.68)	(3.33)
UI(underbar)BENEFIT	120.08	-3.2E-04	-3.2E-04
		-2.8E-04	-2.7E-04
	(17.91)	(6.47)	(6.14)
		(4.47)	(4.42)
UI(underbar)COVER	84.88	-9.7E-04	-6.9E-04
		-5.8E-04	-5.7E-04
	(9.02)	(6.85)	(5.36)
		(4.41)	(4.58)
TAX%	10.33	-.001	-.002
		-.003	-.002
	(1.50)	(1.64)	(2.98)
		(3.15)	(2.80)
WELFARE%	1.92	-4.2E-04	-.006
		-.004	-.003
	(.64)	(.25)	(3.09)
		(1.66)	(1.19)

DEMOGRAPHICS			
MALE(underbar)LF%	61.20	-.001 -.001	-.001 -.001
	(4.90)	(4.46) (4.40)	(4.36) (4.51)
BLACKPOP%	9.50	-5.1E-06 -5.2E-04	-.003 --
	(9.25)	(.03) (1.10)	(1.81) --
MARRIED%	55.31	.002 6.6E-04	-5.2E-04 --
	(4.13)	(2.62) (.56)	(.46) --
CHILDSMAR	11.70	-4.0E-04 -2.7E-04	-.001 --
	(3.73)	(.79) (.34)	(2.12) --
CHILD6NONMAR	1.62	.005 -.002	-.001 --
	(.48)	(2.66) (.50)	(.43) --
AGE65%	.118	-.045 .271	.317 --
	(.019)	(.55) (1.43)	(1.75) --
AGE14%	.233	-.146 -.298	-.486 -.309
	(.027)	(2.38) (2.15)	(3.82) (3.86)
INTMIGRANTS	.001	.844 .309	.408 --
	(.002)	(1.84) (.70)	(1.00) --
HS(underbar)GRAD	67.27	.001 -4.4E-05	-5.4E-04 --
	(9.33)	(4.25) (.08)	(1.07) --
COLL(underbar)GRAD	16.12	-.001 -.005	-.006 -.005

	(3.94)	(2.52)	(5.41)
		(4.60)	(5.86)
OTHER POPDEN	152.70	1.3E-06	1.9E-05
		8.9E-06	--
	(212.08)	(.28)	(.22)
		(.37)	--
LG(underbar)MSA	6.65	6.6E-03	NA
		NA	NA
	(1.21)	(4.87)	--
		--	--
REGION DUMMIES[c]	--	YES	NA
		NA	NA
R[sup 2]	--	.59	.71
		.63	.59
HAUS.-HIGHPUBK[d]	--	NA	NA
		.75	NA
HAUS.-NETPUBK[e]	--	NA	NA
		1.54	NA
HAUS.-WAGECOMP[f]	--	NA	NA
		4.44	NA

NOTE: EMPLOY = employment; HIGHPUBK = the stock of public highways; NETPUBK = the stock of public infrastructure net of highways; INDMIX = controls for whether a state is growing faster simply because it has a concentration of fast-growing industries nationally; INDMIX(underbar)LAG = the lag of INDMIX; FARM, DURABLES, NONDURABLE, MINING, CONSTRUCTION, TRANPU, FIRE, TRADE, and SERVICES = measured by state one-digit employment shares; CriFARM = the change in farm employment as a share of total employment relative to the nation; MILITARY = the change in military expenditures in the state as a share of gross state product relative to the nation; RETIREE = nonlabor force migration such as new retirees each year; REGIONGR = differential employment growth from the United States of the remaining states in a state's census region; REGIONGRL = the lag of REGIONGR; UNION% = the degree of unionization; WAGEMIX = the state employment-weighted average of corresponding national industry wage rates expressed, relative to the average U.S. private wage rate; WAGECOMP = whether the state's wages are relatively high after taking its industry mix into account; FUEL = relative energy prices; UI(underbar)BENEFIT, UL(underbar)COVER = the availability and generosity of unemployment insurance; TAX% = state and local tax burden; WELFARE% = welfare assistance as a percentage of personal income; MALE(underbar)LF% = the percentage of the labor force that is male; BLACKPOP% = the percentage of the population that is Black; MARRIED% = percentage that is married; CHILD6MAR, CHILD6NONMAR = percentage that is married or unmarried women having children 6 years old or younger; AGE65% = percentage that is 65 years or older; AGE14% = percentage that is 14 years or younger; INTMIGRANTS = percentage that is new international migrants; HS(underbar)GRAD = percentage that is above age 24 and graduated high school; COLL(underbar)GRAD = percentage that is college graduates; POPDEN = population density; LG(underbar)MSA = the natural log of the population of the largest standard metropolitan statistical area in the state at the beginning of the sample; NA = not applicable.

a. The dependent variable of the regression is the 1972-1991 state employment growth rate minus the U.S. employment growth rate.

b. Standard deviations and the absolute values of the t statistics are in parentheses. The ordinary least squares results use the White-heteroskedasticity-consistent t statistics.

c. Nine region dummy variables.

d. The Hausman test t statistic for the HIGHPUBK coefficient.
e. The Hausman test t statistic for the NETPUBK coefficient.
f. The Hausman test t statistic for the WAGECOM P coefficient.

TABLE 2: Alternative Autocorrelation-Corrected Fixed Effects Models of Relative Employment[a,b]

Legend for Chart:

A - Variable
B - (1) Without Demand or Structure
C - (2) Without Cost
D - (3) Without Demographics
E - (4) Two-Stage Least Square
F - (5) Including Bordering State Infrastructure

A	B	C E	D F
INFRASTRUCTURE			
HIGHPUBK	.005	.008 .006	.007 .003
	(1.56)	(2.75) (1.95)	(2.80) (1.02)
NETPU BK	6.4E-04	.002 .005	.002 .005
	(.24)	(.66) (1.91)	(1.04) (1.91)
BORD(underbar)HWPUBK	--	-- --	-- .017
	--	-- --	-- (2.84)
DEMAND OR STRUCTURAL			
INDMIX	--	1.98 1.80	1.87 1.78
	--	(19.06) (17.87)	(18.68) (17.75)
INDMIX(underbar)LAG	--	.43 .39	.43 .38
	--	(4.12) (3.91)	(4.36) (3.89)
FARM	--	.198 .040	.003 -.025
	--	(.98) (.21)	(.02) (.13)
DURABLES	--	.143	.127

		.053	.083
	--	(1.99)	(1.56)
		(.61)	(.96)
NONDURABLE	--	.037	.082
		.041	.046
	--	(.50)	(1.13)
		(.52)	(.59)
MINING	--	.088	.013
		-.087	-.069
	--	(.67)	(.09)
		(.57)	(.45)
CONSTRUCTION	--	.985	1.032
		.926	.916
	--	(8.82)	(9.70)
		(8.16)	(8.14)
TRANPU	--	-.641	-.348
		-.425	-.517
	--	(2.44)	(1.41)
		(1.60)	(1.97)
DEMAND OR STRUCTURAL			
FIRE	--	-.916	-.841
		-.754	-.831
	--	(4.38)	(4.50)
		(3.73)	(4.14)
TRADE	--	.071	.233
		.195	.214
	--	(.50)	(2.17)
		(1.41)	(1.55)
SERVICES	--	.202	.269
		.443	.409
	--	(2.12)	(4.05)
		(4.48)	(4.18)
CHFARM	--	.008	.268
		.175	.192
	--	(.05)	(1.63)
		(1.01)	(1.12)
MILITARY	--	-.041	-.095
		-.106	-.111

	--	(.33) (.89)	(.81) (.94)
RETIREE	--	7.22 17.41	15.53 17.88
	--	(1.41) (3.13)	(3.27) (3.20)
REGIONGR	--	.290 .224	.235 .219
	--	(4.61) (3.71)	(3.86) (3.63)
REGIONGRL	--	.198 .082	.042 .084
	--	(3.01) (1.30)	(.66) (1.33)
COST			
UNION%	-3.1E-04	-- 5.1E-04	4.2E-04 3.1E-04
	(.95)	-- (1.71)	(1.47) (1.05)
WAGEMIX	.450	-- .370	.146 .335
	(6.89)	-- (4.58)	(2.18) (4.19)
WAGECOUP	-.079	-- -.233	-.212 -.168
	(2.29)	-- (6.56)	(7.57) (5.14)
FUEL	-.009	-- -.032	-.034 -.031
	(4.46)	-- (3.45)	(3.84) (3.35)
UI(underbar)BENEFIT	-4.1E-04	-- -2.3E-04	-2.9E-04 -2.7E-00
	(5.38)	-- (3.61)	(4.62) (4.26)
UI(underbar)COVER	-.001	-- -5.8E-04	-4.9E-04 -5.6E-04

	(7.50)	--	(4.13)
		(4.43)	(4.27)
TAX%	-.005	--	-.002
		-.003	-.003
	(5.21)	--	(2.71)
		(3.17)	(3.23)
WELFARE%	-.005	--	-1.8E--04
		-.000	-.004
	(1.94)	--	(.08)
		(1.67)	(1.69)
DEMOGRAPHICS			
MALE(underbar)LF%	-.002	-.001	--
		-.001	-.001
	(7.39)	(4.27)	--
		(4.30)	(4.32)
BLACKPOP%	-4.6E-04	-2,6E-04	--
		-5.4E-04	-2.9E-04
	(.86)	(.60)	--
		(1.14)	(.61)
MARRIED%	.002	2.9E-04	--
		9.1E-04	-3,5E-04
	(1.67)	(.24)	--
		(.77)	(.29)
CHILD6MAR	-.001	-.002	--
		9.2E-05	-1.8E-04
	(1.59)	(2.36)	--
		(.12)	(.24)
CHILD6NONMAR	-.004	8.8E-05	--
		-.003	-.002
	(1.01)	(.03)	--
		(.80)	(.51)
AGE65%	.250	.731	--
		.112	.303
	(1.33)	(4.09)	--
		(.58)	(1.61)
AGE14%	-.275	-.009	--
		-.385	-.287
	(1.88)	(.07)	--

		(2.73)	(2.07)
INTMIGRANTS	.299	-.532	--
		.380	.269
	(.55)	(1.16)	--
		(.86)	(.61)
DEMOGRAPHICS			
HS(underbar)GRAD	9.2E-04	-3.7E-04	--
		-1.2E-04	-2.7E-04
	(1.59)	(.70)	--
		(.23)	(.52)
COLL(underbar)GRAD	-.005	-.004	--
		-.005	-.006
	(4.35)	(3.56)	--
		(4.36)	(4.92)
OTHER			
POPDEN	-1.3E-05	-5.9E-05	3.5E-05
		1.7E-05	1.9E-06
	(.48)	(2.83)	(1.56)
		(.69)	(.08)
R[sup 2]	.42	.47	.61
		.63	.62

NOTE: HIGHPUBK = the stock of public highways; NETPUBK = the stock of public infrastructure net of highways; BORD(underbar)HWPUBK = public capital in the bordering states; INDMIX = controls for whether a state is growing faster simply because it has a concentration of fast-growing industries nationally; INDMIX(underbar)LAG = the lag of INDMIX; FARM, DURABLES, NONDURABLE, MINING, CONSTRUCTION, TRANPU, FIRE, TRADE, and SERVICES: measured by state one-digit employment shares; CHFARM = the change in farm employment as a share of total employment relative to the nation; MILITARY = the change in military expenditures in the state as a share of gross state product relative to the nation; RETIREE = nonlabor force migration such as new retirees each year; REGIONGR = differential employment growth from the United States of the remaining states in a state's census region; REGIONGRL = the lag of REGIONGR; UNION% = the degree of unionization; WAGEMIX = the state employment-weighted average of corresponding national industry wage rates expressed, relative to the average U.S. private wage rate; WAGECOMP = whether the state's wages are relatively high after taking its industry mix into account; FUEL = relative energy prices; UI(underbar)BENEFIT, UI(underbar)COVER = the availability and generosity of unemployment insurance; TAX% = state and local tax burden; WELFARE% = welfare assistance as a percentage of personal income; MALE(underbar)LF% = the percentage of the labor force that is male; BLACKPOP% = the percentage of the population that is Black; MARRIED% = percentage that is married; CHILD6MAR, CHILD6NONMAR = percentage that is married or unmarried women having children 6 years old or younger; AGE65% = percentage that is 65 years or older; AGE 14% = percentage that is 14 years or younger; INTMIGRANTS = percentage that is new international migrants; HS(underbar)GRAD = percentage that is above age 24 who are high school graduates; COLL(underbar)GRAD = those who are college graduates; POPDEN = population density.

a. The dependent variable of the regression is the 1972-1991 state employment growth rate minus the U.S. employment growth rate.

b. Absolute values of the t statistics are in parentheses.

REFERENCES

Aschauer, David A. 1989. Is public expenditure productive? Journal of Monetary Economics 23:177-200.
Bell, Michael E., and Therese McGuire. 1993. Macroeconomic analysis of the linkages between transportation investments and economic performance: A draft final report. NCHRP Project 2-17 (3). Washington, D.C.: National Cooperative Highway Research Program.
Berndt, Ernst R., and Bengt Hansson. 1992. Measuring the contribution of public infrastructure capital in Sweden. Scandinavian Journal of Economics 94:151-68.
Blanchard, Olivier J., and Lawrence E Katz. 1992. Regional evolutions. Brookings Papers on Economic Activity 1:1-75.
Carlino, Gerald A., and Richard Voith. 1992. Accounting for differences in aggregate state productivity. Regional Science and Urban Economics 22:597-617.
Crihfield, John B., and Martin P. H. Panggabean. 1995 Growth and convergence in U.S. cities. Journal of Urban Economics 38:138-65
-----. 1996. The structure of metropolitan factor and product markets. Journal of Regional Science 36:17-41.
Dalenberg, Douglas. 1987. Estimates of elasticities of substitution between public and private inputs in the manufacturing sector of metropolitan areas. Ph.D. diss., University of Oregon.
Dalenberg, Douglas, and Mark Partridge. 1995. The effects of taxes, expenditures, and public infrastructure on metropolitan area employment. Journal of Regional Science 35:617-44.
-----. 1997. Public capital's role as productive input and household amenity. Land Economics 73:268-85.
Deno, Kevin T. 1988, The effect of public capital on U.S. manufacturing activity: 1970 to 1978. Southern Economic Journal 55:400-11.
Eberts, Randall. 1986. Estimating the contribution of urban public infrastructure to regional growth. Working Paper 8610. Cleveland, OH: Federal Reserve Bank of Cleveland.
-----. 1990. Public infrastructure and regional economic development. Economic Review of the Federal Reserve Bank of Cleveland 26:15-28.
Eberts, Randall W., and Joe A. Stone. 1992. Wage and employment adjustments in local labor markets. Kalamazoo, MI: Upjohn Institute for Employment Research.
Fox, William F, and Matthew N. Murray. 1990. Local public policies and interregional ***business*** development. Southern Economic Journal 57:413-27.
Garcia-Mila, Teresa, and Therese J. McGuire. 1992. The contribution of publicly provided inputs to states' economies. Regional Science and Urban Economics 22:229-41.
Garcia-Mila, Teresa, Therese I. McGuire, and Robert H. Porter. 1996. The effect of public capital in state-level production functions reconsidered. Review of Economics and Statistics 78:177-80.
Gramlich, Edward M. 1994. Infrastructure investment: A review essay. Journal of Economic Literature 32:1147-75.
Greene, William H. 1993. Econometric analysis. 2d ed. New York: Macmillan.
Hirsch, Barry T, and David A. Macpherson. 1993. Union membership and coverage files from the Current Population Surveys: Note. Industrial and Labor Relations Review 46:574-78.
Holtz-Eakin, Douglas. 1993. State specific estimates of state and local government capital. Regional Science and Urban Economics 23:185-209.
-----. 1994. Public-sector capital and the productivity puzzle. Review of Economics and Statistics 76:12-21.
Holtz-Eakin, Douglas, and Mary E. Lovely. 1996. Scale economies, returns to variety, and the productivity of public infrastructure. Regional Science and Urban Economics 26:105-23.
Holtz-Eakin, Douglas, and Amy Ellen Schwartz. 1995. Infrastructure in a structural model of economic growth. Regional Science and Urban Economics 25:131-51.
Hulten, Charles R., and Robert M. Schwab. 1991. Public capital formation and the growth of regional manufacturing industries. National Tax Journal 44:121-34.
-----. 1993. Infrastructure spending: Where do we go from here? National Tax Journal 46:261-73.
Immergluck, Daniel W. 1993. The role of public infrastructure in urban economic development. Economic Development Quarterly 7:310-38.
Kelejian, Harry H., and Dennis P. Robinson. 1993. A suggested method of estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model. Papers in Regional Science 72 (3):297-312.
-----. 1997. Infrastructure productivity estimation and its underlying econometric specifications: A sensitivity analysis. Papers in Regional Science 76:115-31.
Lynde, Catherine, and James Richmond. 1992. The role of public capital in production. The Review of Economics and Statistics 74:37-44.

Meade, James E. 1952. External economies and diseconomies in a competitive situation. Economic Journal 62:54-67.
Mera, Koichi. 1973. Production functions and social overhead capital: An analysis of the Japanese case. Regional and Urban Economics 3 (2):157-86.
Moomaw, Ronald L., John K. Mullen, and Martin Williams. 1995. The interregional impact of infrastructure capital. Southern Economic Journal 61:830-45.
Morrison, Catherine, and Amy Schwartz. 1996. State infrastructure and productive performance. American Economic Review 86:1095-111.
Munnell, Alicia H. 1990, How does public infrastructure affect regional economic performance? New England Economic Review, September/October, 11-32.
-----. 1992. Infrastructure investment and economic growth. Journal of Economic Perspectives 6:189-98.
Nadiri, M. Ishaq, and Theofanis P. Mamuneas. 1994. The effects of public infrastructure and R&D capita/on the cost structure and performance of U.S. manufacturing industries. Review of Economics and Statistics 76:22-37.
Newman, Robert J., and Dennis H. Sullivan. 1988. Econometric analysis of ***business*** tax impacts on industrial location: What do we know, and how do we know it? Journal of Urban Economics 23:215-34.
Partridge, Mark D., and Dan S. Rickman. 1995. Differences in state unemployment rates: The role of labor and product market structural shifts. Southern Economic Journal 62:89-106.
Pinnoi, Nat. 1994. Public infrastructure and private production: Measuring relative contributions. Journal of Economic Behavior and Organization 23:127-48.
Rather, Jonathan B. 1983. Government capital and the production function for U.S. private output. Economics Letters 13:213-17.
Renshaw, Vernon, Edward A. Trott, and Howard L. Friedenberg. 1988. Gross state product by industry, 1963-86. Survey of Current ***Business*** 68:43-59.
Seitz, Helmut, and George Licht. 1995. The impact of public infrastructure capital on regional manufacturing production cost. Regional Studies 29:231-40.
Shah, Anwar. 1992. Dynamics of public infrastructure, industrial productivity and profitability. Review of Economics and Statistics 74:28-36.
Tatom, John A. 1991. Public capital and private sector performance. Federal Reserve Bank of St. Louis Review, March/April, 3-15.
Treyz, George 1., Dan S. Rickman, Gary L. Hunt, and Michael J. Greenwood. 1993. The dynamics of U.S. internal migration. Review of Economics and Statistics 75:209-14.
Treyz, George I., Dan S. Rickman, and Gang Shao. 1992. The REMI economic-demographic forecasting and simulation model. International Regional Science Review 14 (3):221-53.
U.S. Bureau of the Census. 1970. Census of population, decennial. Washington, D.C.: Government Printing Office.
U.S. Bureau of the Census. 1980. Census of population, decennial. Washington, D.C.: Government Printing Office.
U.S. Bureau of the Census. 1990. Census of population, decennial. Washington, D.C.: Government Printing Office.
Wasylenko, Michael, and Therese McGuire. 1985. Jobs and taxes: The effect of ***business climate*** on states' employment growth rates. National Tax Journal 38:497-511.

By DOUGLAS R. DALENBERG, University of Montana, MARK D. PARTRIDGE, St. Cloud University and DAN S. RICKMAN, Oklahoma State University

Douglas R. Dalenberg is an associate professor of economics at the University of Montana. His research interests are regional development and transportation. His recent articles have appeared in the Journal of Regional Science and Land Economics

Mark D. Partridge is an assistant professor of economics at St. Cloud University. His research interest is regional labor markets. Recent publications include articles in the Southern Economic Journal, Journal of Labor Research, Journal of ***Business*** and Economic Statistics, Economic Letters, Land Economics, and the Journal of Regional Science, among others

Dan S. Rickman is a professor of economics and OG&E chair in regional economic analysis at Oklahoma State University. His research interests include regional public finance, regional modeling, and regional labor markets. He has published articles in the American Economic Review, Review of Economics and Statistics, Southern Economic Journal, Journal of Urban Economics, Journal of ***Business*** and Economic Statistics, Journal of Regional Science, and Economics Letters, among others.

Source: Public Finance Review, Jan98, Vol. 26 Issue 1, p24, 29p, 2 charts.
Item Number: 34651